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DRAFT FINAL OPERATIONAL RANGE ASSESSMENT PROGRAM PHASE 1 QUALITATIVE  
ASSESSMENT REPORT FOR FORT STORY VA WITH TRANSMITTAL LETTERS FORT  
STORY VA  
11/1/2006  
EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.



# DRAFT FINAL

## Operational Range Assessment Program Phase I Qualitative Assessment Report **Fort Story, Virginia**

Prepared for:

U.S. Army Environmental Command and  
U.S. Army Corps of Engineers Baltimore District



November 2006





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30 November 2006

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**RE: Draft Final Operational Range Assessment Program  
Phase I Qualitative Assessment Report  
Fort Story, Virginia**

Dear Ms. Bateman:

1. Enclosed (1 hard copy and 2 electronic copies) is the Draft Final Operational Range Assessment Program Phase I Qualitative Assessment Report for Fort Story. In addition to the report, the electronic copies also include a copy of the Read-Ahead Package, Site Visit Trip Report, and the Response to Comments documents for the Draft version of the report. The Deputy Assistant Secretary of the Army, (Environment, Safety and Occupational Health) has recently directed that individual Phase I Assessment Reports be finalized on a single date after all the Phase I Range assessments have been completed. It is currently planned that these assessments will be finalized in FY09.
2. The reason for the single finalization date is that the assessments will be used to identify and prioritize ranges that need further assessment. Therefore, it is critical that the assessments are defensible and conducted in a standardized manner. The U.S. Army Environmental Command (USAEC) and the U.S. Center for Health Promotion and Preventive Medicine (USACHPPM) are providing program oversight and utilizing a standardized protocol to ensure assessment have consistency and defensibility to allow an "apples to apples" evaluation for prioritization.
3. The final check for standardization will be conducted by USAEC and USACHPPM. Once this has been completed, the contractors will be directed to finalize the Phase I Assessment Reports with any required changes and forward them to you.
4. The Draft Range Assessment Technical Outreach Guidance (TOG) and a Department of Defense Memorandum are also enclosed. These documents provide additional information regarding how to address questions regarding the range assessment report. The final TOG and any new guidance will be provided to you as it is developed.



5. If you have any questions regarding this matter, please call John Buck at USAEC at 410-436-4844 and Jennifer Martin, Team Leader, at 315-431-4610.

Regards,

EA ENGINEERING, SCIENCE,  
AND TECHNOLOGY, INC.

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**DRAFT FINAL  
OPERATIONAL RANGE ASSESSMENT PROGRAM  
PHASE I QUALITATIVE ASSESSMENT REPORT  
FORT STORY  
VIRGINIA BEACH, VIRGINIA**

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NOVEMBER 2006

Prepared for:

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**DRAFT FINAL  
OPERATIONAL RANGE ASSESSMENT PROGRAM  
PHASE I QUALITATIVE ASSESSMENT REPORT  
FORT STORY  
VIRGINIA BEACH, VIRGINIA**

DoD Contract Number:

W912DR-05-D-0008

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EA Engineering, Science, and Technology, Inc. prepared this report at the direction of the United States Army Corps of Engineers (USACE). This document should be used only with the approval of the USACE or another authorized Department of the Army official organization. This report is based, in part, on information provided in other documents and is subject to the limitations and qualifications presented in the referenced documents.

**NOVEMBER 2006**

## TABLE OF CONTENTS

ABBREVIATIONS/ACRONYMS.....	iv
EXECUTIVE SUMMARY .....	ES-1
1.0 Introduction.....	1-1
1.1 Project Drivers, Scope, and Objectives.....	1-1
1.2 Purpose.....	1-1
1.3 General Installation Information.....	1-2
2.0 Assumptions, Programmatic Exclusions, and Data Collection Efforts .....	2-1
2.1 Assumptions.....	2-1
2.2 Programmatic Exclusions .....	2-1
2.2.1 Exposure to Surface Water .....	2-1
2.2.2 Exposure to Groundwater .....	2-1
2.2.3 Surface Soil.....	2-1
2.2.4 Air Emissions.....	2-2
2.2.5 Potential Receptors .....	2-2
2.2.5.1 Terrestrial Receptor Consumption.....	2-2
2.3 Summary of Data Collection Efforts .....	2-2
3.0 Conceptual Site Model Profiles .....	3-1
3.1 Facility Profile .....	3-1
3.1.1 Current and Historic Range Layout .....	3-1
3.1.2 Munitions Types and Usage.....	3-2
3.2 Physical Profile .....	3-3
3.2.1 Meteorology.....	3-3
3.2.2 Topography .....	3-3
3.2.3 Geology.....	3-3
3.2.4 Hydrogeology .....	3-3
3.2.5 Soils.....	3-4
3.2.6 Surface Water.....	3-4
3.2.7 Vegetation .....	3-4
3.3 Munitions/Release Profile.....	3-4

3.3.1	Potential MCOC.....	3-4
3.3.2	Release Mechanisms/Migration Pathways .....	3-5
3.4	Land Use and Human Receptor Profile .....	3-5
3.4.1	Current Land Use.....	3-5
3.4.2	Adjoining Areas of Concern .....	3-6
3.4.3	Current Human Receptors.....	3-6
3.4.4	Resource Use Location .....	3-6
3.5	Ecological Receptor Profile .....	3-6
3.5.1	Sensitive Environments .....	3-6
3.5.2	Habitat Type(s) .....	3-6
3.5.3	Ecological Receptors .....	3-6
3.6	Relationship of Potential MCOC Sources to Habitat and Potential Off-Range Receptors .....	3-7
4.0	Grouping and Categorization Methods .....	4-1
4.1	Grouping Rationale.....	4-1
4.2	Categorization Rationale.....	4-1
5.0	Conceptual Site Model Narrative.....	5-1
5.1	Group LS.....	5-1
5.1.1	Primary Source and MCOC .....	5-1
5.1.2	Source Media .....	5-1
5.1.3	Pathway Analysis.....	5-1
5.1.4	Potential Source-Human Interaction Pathway Analysis .....	5-1
5.1.5	Potential Source-Ecological Interaction Pathway Analysis.....	5-1
5.2	Group MSWGW (E).....	5-1
5.2.1	Primary Source and MCOC .....	5-1
5.2.2	Source Media .....	5-2
5.2.3	Pathway Analysis.....	5-2
5.2.4	Potential Source-Human Interaction Pathway Analysis .....	5-2
5.2.5	Potential Source-Ecological Interaction Pathway Analysis.....	5-2
5.3	Data Uncertainty .....	5-2
6.0	Conclusions and Recommendations .....	6-1



### List of Figures

Figure 1-1: General Location of Fort Story .....	1-3
Figure 1-2: General Layout and Operational Range Area .....	1-4
Figure 3-1: Topography .....	3-8
Figure 3-2: Site Hydrogeology .....	3-9
Figure 3-3: Surface Water, Wetlands, and Threatened and Endangered Species.....	3-10
Figure 5-1: Individual Range Groupings .....	5-4
Figure 5-2: Conceptual Site Model Group LS.....	5-5
Figure 5-3: Conceptual Site Model Group MSWGW (E) .....	5-6
Figure 6-1: Summary of Conclusions for Fort Story .....	6-3

### List of Tables

Table ES-1: Summary of Findings, Conclusions, and Recommendations for Fort Story .	ES-2
Table 3-1: Fort Story Operational Range Areas.....	3-2
Table 3-2: Source Areas and Potential MCOC at Fort Story .....	3-4
Table 5-1: Summary of the Conceptual Site Model Components.....	5-3
Table 6-1: Summary of Conclusions and Recommendations for Fort Story .....	6-2

### List of Appendices

Appendix A: Glossary of Terms .....	A-1
Appendix B: References	
B1 – General/Project Drivers and Guidance Documents .....	B1-1
B2 – References .....	B2-1
B3 – Data Repositories and Databases .....	B3-1
B4 – On-Installation Sources/Repositories .....	B4-1
B5 – Personnel Interviews .....	B5-1
B6 – Off-Installation Sources/Repositories .....	B6-1

## ABBREVIATIONS/ACRONYMS

ARID-GEO	Army Range Inventory Geodatabase
CSM	Conceptual Site Model
DNT	Dinitrotoluene
DoD	Department of Defense
DODD	Department of Defense Directive
DODI	Department of Defense Instruction
EOD	Explosive Ordnance Disposal
GIS	Geographic Information System
H/E	Human/Ecological
HMX	Cyclotetramethylenetetranitramine
JLOTS	Joint Logistics Over the Shore
LS	Limited or No Source Munition
MC	Munitions Constituents
MCOC	Munitions Constituents of Concern
MGW	Munitions/Groundwater
MPU	Migration Pathway Unlikely
MSW	Munitions/Surface Water
MSWGW	Munitions/Surface Water and Groundwater
ORAP	Operational Range Assessment Program
PETN	Pentaerythritoltetranitrate
RDX	Cyclotrimethylenetrinitramine
TNT	Trinitrotoluene
U.S.	United States
USACE	United States Army Corps of Engineers
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
USAEC	U.S. Army Environmental Center
U.S.C.	United States Code

## EXECUTIVE SUMMARY

### PURPOSE

This qualitative assessment, hereinafter referred to as Phase I Assessment, evaluates Fort Story's operational range area to assess whether further investigation is needed to determine if potential munitions constituents of concern (MCOC) are or could be migrating off-range at levels that may pose an unacceptable risk to human health or the environment. The Phase I Assessment results in the categorization of operational ranges as appropriate, as follows:

- **Referred – Refer to Appropriate Cleanup Program:** Ranges with compelling evidence (e.g., sampling data) to indicate the presence of an off-range release that potentially poses an unacceptable risk to human health or the environment;
- **Inconclusive – Phase II Quantitative Assessment Required:** Ranges where existing information either is insufficient to make a source-receptor interaction determination or indicates the potential for such interaction to be occurring; or
- **Unlikely – Five-Year Review<sup>1</sup>:** Ranges where, based upon a review of readily available information, there is sufficient evidence to show that there are no known releases or source-receptor interactions that could present an unacceptable risk to human health or the environment based on a review of the information available.

### SUMMARY OF FINDINGS

To facilitate the qualitative analysis, MCOC sources, potential migration pathways from a range, and potential off-range human and/or ecological receptors associated with the ranges at Fort Story were evaluated as appropriate. Each range was then placed into one of several descriptive groups that meet the criteria for the Inconclusive and Unlikely categories.

The 21 operational ranges at Fort Story that were included in the qualitative assessment have placed into the following two categories:

- **Inconclusive**—One 19.4-acre range, consisting of the Navy Explosive Ordnance Disposal training area.
- **Unlikely**—Twenty ranges consisting of maneuver and training areas, totaling 843 acres.

These findings are summarized in **Table ES-1**.

<sup>1</sup> All operational ranges must be periodically re-evaluated to determine if there is a release or substantial threat of release of MCOC from an operational range to an off-range area. Range groups categorized as Unlikely are to be re-evaluated at least every five years. Re-evaluation may occur sooner if significant changes (e.g., changes in range operations, site conditions, and regulatory changes) occur that affect determinations made during the Phase I Assessment.

**Table ES-1: Summary of Findings, Conclusions, and Recommendations for Fort Story**

Category	Group Identification	Total Number of Ranges and Acreage	Source(s)	Pathway(s)*	Human Receptors*	Ecological Receptors*	Recommendations (Future Steps)
Inconclusive	Munitions used; groundwater pathway present	One operational range; 19.4 acres	Explosive Ordnance Disposal and training areas	Groundwater	None	Threatened and endangered species	Phase II Quantitative Assessment is required.
Unlikely	Limited source	20 operational ranges; 843 acres	No source – limited or no military munitions use	Not evaluated	Not evaluated	Not evaluated	Re-evaluate during the five-year review.
* Indicates the specific pathways of concern.							



## 1.0 Introduction

The United States (U.S.) Army is conducting qualitative assessments at operational ranges to meet the requirements of Department of Defense (DoD) policy and to support the U.S. Army Sustainable Range Program. The operational range qualitative assessment (hereinafter referred to as Phase I Assessment) is the first phase of the U.S. Army Operational Range Assessment Program (ORAP). The Phase I Assessment will review readily available data to evaluate, verify, validate, document, and report on operational ranges within the United States and its territories. Phase I Assessments are being conducted on Active Army, Army Reserve, and Army National Guard installations (including both federal and state owned).

The conclusions in this report have been based, in part, on information obtained from third parties, including historical aerial photographs, environmental agency records, well logs, and other public geologic records regarding the sites obtained from various sources. Unless noted, EA Engineering, Science, and Technology, Inc. has not independently evaluated or verified the accuracy or completeness of such third party information. Visual observations of the site only represent conditions at the time of the site visit. EA Engineering, Science, and Technology, Inc. makes no warranties that the on-site observations made during the site visit are representative of historical or future conditions at the site.

### 1.1 Project Drivers, Scope, and Objectives

The Phase I Assessment process evaluates potential source-receptor interaction between off-range<sup>2</sup> receptors and the migration of potential munitions constituents of concern (MCOC) from an operational range.

The ORAP is being implemented to fulfill requirements identified implicitly or explicitly in:

- DoD Directive (DODD) 4715.11 *Environmental and Explosives Safety Management on Operational Ranges within the United States*, 10 May 2004; and
- DoD Instruction (DODI) 4715.14 *Operational Range Assessments*, 30 November 2005.

### 1.2 Purpose

The purpose of this Phase I Assessment is to evaluate Fort Story's operational ranges to assess whether further investigation is needed to determine if potential MCOC are or could be migrating off-range at levels that may pose an unacceptable risk to human health or the environment.

Based on the readily available data obtained during the Phase I Assessment process, all operational ranges at Fort Story were placed into groups according to military munitions use, the presence or absence of potential MCOC, migration pathways, and receptors. Each operational range group was then placed into one of three possible categories: Referred, Inconclusive, or Unlikely.

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<sup>2</sup> Off-range areas include those areas outside of the boundaries of the operational range area, as established by the Army Range Inventory Geodatabase (ARID-GEO). Off-range areas may include both on-installation (i.e., cantonment areas) and off-installation areas or locations.



- **Referred – Refer to Appropriate Cleanup Program:** Ranges with compelling evidence (e.g., sampling data) to indicate the presence of an off-range release that potentially poses an unacceptable risk to human health or the environment;
- **Inconclusive – Phase II Quantitative Assessment Required:** Ranges where existing information either is insufficient to make a source-receptor interaction determination or indicates the potential for such interaction to be occurring; or
- **Unlikely – Five-Year Review<sup>3</sup>:** Ranges where, based upon a review of readily available information, there is sufficient evidence to show that there are no known releases or source-receptor interactions that could present an unacceptable risk to human health or the environment based on a review of the information available.

Appendix A provides a glossary of common terms referred to in the ORAP.

### 1.3 General Installation Information

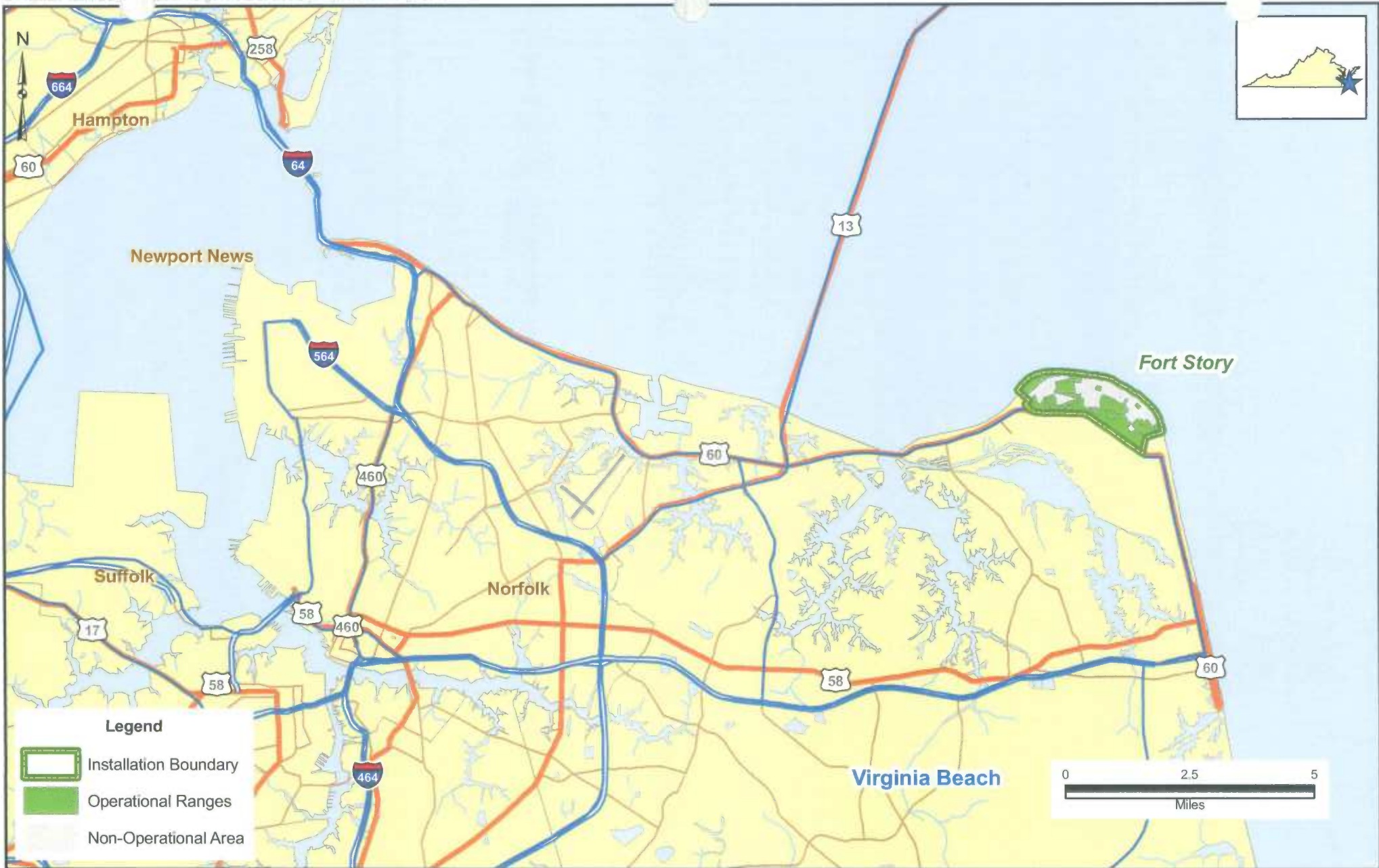
Fort Story is an active Army training facility located on the southern coast of Virginia (**Figure 1-1**). The installation occupies 1,454 acres and is located on the Cape Henry Peninsula. Fort Story is approximately 18 miles east of Norfolk, Virginia; 27 miles southeast of Hampton, Virginia; and 105 miles southeast of Richmond, Virginia. First Landing State Park, formerly Seashore State Park, which is a densely forested wetland and maritime forest area, borders Fort Story to the south. A residential area is located along a small portion of the southwestern-most boundary. The remaining boundaries are formed by the Atlantic Ocean to the northeast and the Chesapeake Bay to the northwest.

Fort Story was established as a military installation in 1914 with a land gift to the U.S. Government from the Virginia General Assembly. Several artillery installations were constructed at Fort Story during World War I, including it among the most heavily fortified on the Atlantic Coast. At this time, Fort Story was integrated into the Coastal Defenses of the Chesapeake Bay with Fort Monroe and Fort Wool. In 1925, Fort Story was designated a Harbor Defense Command. Post-World War I saw a period of inactivity at Fort Story that lasted until the onset of World War II. In 1941, two additional installations were added to the Harbor Defense Command network, the headquarters of which were moved to Fort Story. From 1944 to 1946, Fort Story transitioned from a fortified defense to a hospital for soldiers returning from Europe. During this time, more than 13,000 soldiers passed through the hospital. After World War II, the Fort Story mission changed to amphibious landings and Joint Logistics Over the Shore (JLOTS) training with the arrival of the 458<sup>th</sup> Amphibious Truck Company.

In 1962, Fort Story was designated as a sub-installation of Fort Eustis, which is approximately 45 miles to the northeast. Since then, the mission of Fort Story has focused on amphibious landing maneuvers as it is the Army's only installation conducting JLOTS training. Active and reserve units from the Army, Navy, and Marines use Fort Story as a joint training facility (Fort Story 2006). **Figure 1-2** depicts the layout and operational range area identified in the March 2006 ARID-GEO.

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<sup>3</sup> All operational ranges must be periodically re-evaluated to determine if there is a release or substantial threat of release of MCOC from an operational range to an off-range area. Range groups categorized as Unlikely are to be re-evaluated at least every five years. Re-evaluation may occur sooner if significant changes (e.g., changes in range operations, site conditions, and regulatory changes) occur that affect determinations made during the Phase I Assessment.



**Operational Range Assessment Program  
Phase I Qualitative Assessment  
Fort Story, VA**

**Figure 1-1  
General Location of Fort Story**

Data Sources: ESRI, 2005, ARID-GEO 2006

Date: .....November 2006  
Prepared By: .....EA Engineering Science and Technology  
Prepared For: .....U.S. Army  
Contract Number: .....W912DR-05-D-004







**Operational Range Assessment Program  
Phase I Qualitative Assessment  
Fort Story, VA**

**Figure 1-2  
General Layout and Operational Range Area**

Data Sources: ESRI 2005, ARID-GEO 2006

Date: .....November 2006  
Prepared By: ...EA Engineering Science and Technology  
Prepared For: ..... U.S. Army  
Contract Number: ..... W912DR-05-D-004

## **2.0 Assumptions, Programmatic Exclusions, and Data Collection Efforts**

### **2.1 Assumptions**

Statements in this report were made using available supporting documents and data obtained during the centralized data collection efforts and site visit conducted at Fort Story on 18 April 2006. The findings and conclusions of the supporting documents and data are assumed to be accurate and scientifically defensible. Conclusions and recommendations are based on the data gathered during the Phase I Assessment.

The Phase I Assessment assumes that the primary pathways for off-range migration are water related. This is to conform to the DODI 4715.14 emphasis on off-range migration (DoD, 2005). The water media are surface water, sediment, and groundwater. Other media may be considered if warranted based on site-specific conditions.

### **2.2 Programmatic Considerations and Exclusions**

For the purposes of the Phase I Assessment, an unacceptable risk to human health or the environment only occurs if there is a source of MCOC, a pathway for MCOC to move off-range, and an off-range receptor has been identified that will be impacted by the migrating MCOC. The paragraphs below present the potential pathways and receptors considered for the Phase I Assessments. Potential MCOC migration pathways that have been evaluated and programmatically excluded (except in unique situations that compel their inclusion) are also presented.

#### **2.2.1 Exposure to Surface Water**

The U.S. Environmental Protection Agency (USEPA) *Guidance for Performing Preliminary Assessments under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)* (1991) requires the identification of potential surface water receptors up to 15 miles downstream from the location at which potential MCOC may move beyond the aerial extents of the source area. This is the location farthest downstream that MCOC enter the surface water pathway. Only those surface water receptors identified in the surface water pathway segments downstream of the operational range area boundary are being evaluated and assessed.

Dermal contact and incidental ingestion of MCOC within the off-range surface water pathway, for areas other than designated recreational areas (or areas known or suspected of being used frequently for swimming), are programmatically excluded. While surface water may be a viable exposure pathway in some instances, it is not expected to be significant in most cases due to the extremely low levels of MCOC that have been found in surface water during previous quantitative range studies conducted by United States Army Center for Health Promotion and Preventive Medicine (USACHPPM). Therefore, USACHPPM has recommended that this pathway only be evaluated when there is evidence that the surface water body is used regularly for swimming (USACHPPM, 2005).

#### **2.2.2 Exposure to Groundwater**

For human receptors to contact MCOC through the groundwater pathway there must be an aquifer, a drinking water well, or discharge to a stream or spring that is used as a drinking water source. The USEPA (1991) requires the identification of water wells, both public and private, within four miles down gradient of the potential MCOC source area. For the Phase I Assessments, wells are identified



within four miles of the potential MCOC source area boundary.

### **2.2.3 Surface Soil**

The surface soil pathway is not to be evaluated unless potential off-range human or ecological receptors are present within 200 feet of a suspected source of MCOC. This determination is based on the USEPA (1991). In general, the results of a variety of range studies indicate that the likelihood of encountering potential source-receptor interactions through the soil pathway is extremely low.

### **2.2.4 Air Emissions**

Air emissions from detonating military munitions have been evaluated under a variety of studies conducted by the DoD, the Army, and the Emergency Planning and Community Right-to-Know Act's Toxic Release Inventory and for Agency for Toxic Substances and Disease Registry purposes. These studies indicate that off-range receptor exposure to MCOC via the air pathway does not pose an unacceptable level of risk. Therefore, the U.S. Army Environmental Command (USAEC) has decided on a programmatic basis not to evaluate the air emissions migration pathway further during the Phase I Assessment. Should additional information become available that identifies potential problems associated with the air emissions migration pathway, this decision will be re-evaluated.

### **2.2.5 Potential Receptors**

Receptors are organisms (human or ecological) that contact a chemical or physical agent in the environment. For the purposes of the Phase I Assessment, receptors are generally limited to off-range human receptors (workers, residents, and recreational users [including trespassers]) and off-range ecological receptors (threatened and endangered species; wetlands; fisheries; and other ecological receptors of concern or sensitive environments specific to an installation). Ecological receptors should include the identification and location of sensitive terrestrial/avian environments within one-half mile of the potential source areas, and fisheries and surface water sensitive environments up to 15 miles downstream of the probable point of entry (USACHPPM, 2005; Malcolm Pirnie, 2005). For the purposes of the Phase I Assessments, sensitive environments are considered surrogates for ecological receptors. Guidance on identifying a sensitive environment was obtained from Exhibit 1-1 of the USEPA (1997).

#### **2.2.5.1 Terrestrial Receptor Consumption**

Studies conducted by the USACHPPM and other organizations indicate that the uptake and bioaccumulation of select MCOC (e.g., explosives) in terrestrial receptors do not pose a viable health risk to off-range receptors. Therefore, a potential source-receptor interaction pathway that results from the consumption of terrestrial receptors (e.g., deer) is excluded from the ORAP.

These investigations show that deer and other wildlife species exposed to higher levels of MCOC in soil, especially around explosive manufacturing areas, do not contain detectable levels of military unique compounds. Although some heavy metals, such as mercury, can bioaccumulate within edible tissue, findings are inconsistent with terrestrial populations found both on- and off-range. Based on the data gathered during these investigations, and considering the conservatism and uncertainty related to the risk assessment process, the health risk with consuming deer and other game harvested on-range is no greater than with harvesting game off-range. Therefore, consumption of terrestrial wildlife, migratory birds, and livestock are programmatically excluded.



The inclusion of fish as a potential pathway / exposure point via the food chain is supported by USACHPPM. This assumption is based on the theory that if MCOC are present in a water body, fish have a more intensive, long-term exposure potential than terrestrial receptors, which may only come into contact with the contamination during incidental, short-term exposures.

### **2.3 Summary of Data Collection Efforts**

Five primary sources of information were researched as part of the data collection effort for the Phase I Assessment:

- Data repositories and databases (e.g., U.S. Army Technical Information Center, Geographic Information System [GIS] Repository, ARID-GEO);
- Installation data repositories (e.g., Integrated Natural Resources Management Plan, Environmental GIS data);
- Personal interviews (e.g., Training Division and Environmental Division);
- Windshield survey; and
- Off-installation data sources and repositories (e.g., U.S. Fish and Wildlife Service, Virginia Department of Health, and Natural Resources Conservation Service).

Prior to the site visit, information on Fort Story and the surrounding area was obtained from centralized databases and assembled into several profiles. Data gaps regarding munitions usage and off-range receptors were identified from this effort. A site visit to Fort Story was made from 18 to 20 April 2006 to verify the collected information and fill data gaps. Interviews with personnel from Fort Story Range Control, Environmental Division, and the Integrated Training Area Management also provided useful information. All of this information was used to construct the conceptual site model (CSM) profiles discussed throughout this report.

**Appendix B** lists references used in the Phase I Assessment.

### 3.0 Conceptual Site Model Profiles

Section 3 provides a description of the installation and its environment based on information obtained during the Phase I Assessment process. The section includes five profile types:

- Facility profile: Describes man-made features and potential sources (for example, the current and historical installation area/layout and the munitions type/usage associated with the operational range area).
- Physical profile: Describes physical features/factors that may affect release, transport, and access of potential MCOC (for example, meteorological data, topography, geology, hydrogeology, and surface waters and water resource use).
- Munitions/release profile: Describes potential MCOC and associated release mechanisms/pathways.
- Land use and exposure profile: Provides information used to identify and evaluate the applicable exposure scenarios, receptors, and receptor locations.
- Ecological profile: Describes natural habitats of the installation and associated ecological receptors.

#### 3.1 Facility Profile

##### 3.1.1 Current and Historic Range Layout

The Fort Story cantonment area is located in the northeastern quarter of the installation. The land area designated for training at Fort Story is situated throughout the installation and covers an area of approximately 862 acres of the 1,454-acre facility (**Figure 1-2**). A parade ground is the only training area located in the cantonment area. There are a total of 21 training areas, including a Navy Explosive Ordnance Disposal (EOD) training area.

##### Training Areas

There are a total of 20 non-live-fire training and maneuver areas at Fort Story covering an area of approximately 843 acres (**Table 3-1**). Five training areas used for JLOTS training are located along the northern boundary, bordering the Chesapeake Bay. JLOTS training consists of the loading and unloading of deep water ships to the shore in areas without port facilities. In the central area of the installation, three training areas are used for maneuvers and training. To the south of these areas there are five additional training areas, three of which extend east to west along the southern installation boundary. The remaining seven training areas are located in the west-central portion of the installation. Only small caliber blanks and pyrotechnics are authorized to be used in these areas (Personal communication, Fort Story Range Operations, Range Officer and Fort Story Range Operations, Antiterrorism Officer).

**Table 3-1: Fort Story Operational Ranges**

Range Type	Number of Ranges	Total Acreage
Maneuver and Training Areas	20	843
Live-Fire Ranges	1	19.4
Total	21	862
NOTE: Data source (ARID-GEO 2006)		

### **Navy Explosive Ordnance Disposal**

The Navy EOD training area at Fort Story has been used continuously for at least 30 years. The 19.4-acre Navy EOD training area is surrounded by non-live-fire maneuver and training areas. The EOD training area contains two regions where live charges are detonated, a hardened bunker (Casemate 807), and an adjacent open area. The maximum donor charge size allowed within the hardened bunker is five pounds, and 0.5 pounds outside of the bunker (Geo-Marine 2005). The nature and size of the munitions disposed at the EOD training area, both inside and outside of the hardened bunker, are not known. To the west of the live-fire EOD range is the EOD practice course, which consists of abandoned vehicles and inert munitions. Pyrotechnic simulators are used in this area (Personal communication, Fort Story Range Operations, Range Officer and Fort Story Range Operations, Antiterrorism Officer).

### **3.1.2 Munitions Types and Usage**

#### **Munitions Types**

Each of the following classes of munitions has been used at Fort Story:

- **Small Caliber Munitions:** Used in small arms and are typically fired from weapons with a muzzle diameter of up to 50 caliber, or 0.5-inch. Projectiles are typically solid, composed of lead cores with copper alloy jackets. More recently, tungsten-nylon core projectiles (formerly referred to as green ammunition) have been substituted to reduce lead usage at Fort Story. Small caliber practice munitions (commonly referred to as blanks) contain no projectiles.
- **Pyrotechnics and Obscurants:** Devices that give off smoke, light, and/or loud noise when activated. Common munitions in this category include smoke grenades, artillery simulators; ground burst simulators, hand grenade simulators, and booby trap simulators.
- **Other Weapons Systems:** Hand grenades, bombs, rockets, missiles, and mines all fall under this category. Generally, these munitions may be found in live-fire ranges or impact areas. Items such as detonation cords and charges may be used in demolition areas. Munitions in this category may also be divided further into live-fire practice sub-categories.

#### **Reported Munitions Usage**

Range Facility Management Support System data collection began in December 2005 at Fort Story; therefore, there was not a sufficient amount of data available for review. Information regarding type and quantity of munitions used at the Navy EOD training area was requested during the site visit but was not provided.



## **3.2 Physical Profile**

### **3.2.1 Meteorology**

Situated on the Virginia coast, Fort Story is located in a maritime climate zone that experiences an average annual temperature of 60° Fahrenheit (Montgomery Consulting Engineers, Inc. 1991). The winters in this region are mild with an average temperature for the winter months of 45° Fahrenheit. The warm summer months have an average temperature of 85° Fahrenheit. The precipitation in the area is mostly in the form of rain. Average total annual precipitation is 45 inches; annual total snowfall is 7.3 inches.

### **3.2.2 Topography**

Fort Story is situated in the Atlantic Coastal Plain physiographic province, which is characterized by narrow well drained ridges separated by poorly drained wetlands with coastal areas (Geo-Marine, Inc. 2005). The inland topography at Fort Story generally consists of sand flats broken up by sand ridges and wetland areas (**Figure 3-1**). Wide sandy beaches line the coast along the northern installation boundary. South of the beach area, a series of large dunes rise up to form a barrier to the ocean between the beach and the sand flat farther inland. A large ridge is located to the south of the sand flats. The maximum height of this ridge is 85 feet above mean sea level. This ridge trends in a northwest to southeast direction and is the most prominent land form at Fort Story. South of the ridge line is a large low-lying thickly forested wetland region and maritime forest, which continues east beyond the installation boundary to Broad Bay.

### **3.2.3 Geology**

Fort Story is located in the Virginia Coastal Plain, which consists of eastward thickening and dipping sediments of generally unconsolidated, interbedded sands and clays with minor amounts of gravel and shell fragments. This section of unconsolidated deposits is more than 3,500 feet thick in the Fort Story region, and is underlain by crystalline basement rocks (Geo-Marine, Inc. 2005).

The surficial geology of the Fort Story consists of unconsolidated sand and clay deposits with small amounts of gravels and shell fragments (Montgomery Consulting Engineers, Inc. 1991). Long-term changes in sea level and short-term tidal fluctuation have reworked and inter-mixed the Holocene deposits with beach and marsh deposits consisting of river and estuarine sands, silts, and clays with some intermixed gravel and localized areas of organic material along the eastern border of Fort Story.

### **3.2.4 Hydrogeology**

There are six aquifers in the Fort Story area (Malcolm Pirnie, Inc. 2002, 2005). The Columbia Aquifer is the surface aquifer of the region and is encountered between 2.5 feet and 40 feet below ground surface. The Columbia Aquifer is found in the Holocene beach and near shore sand deposits of the Columbia Group, and it extends to a depth as great as 120 feet below ground surface. A large ridge striking northwest to southeast in the middle of Fort Story divides the flow of the Columbia Aquifer (**Figure 3-2**).

Beneath the Columbia Aquifer is the Yorktown-Easton Aquifer. These two aquifers are separated by the 15- to 20-foot thick Yorktown confining unit which consists of marine silts with minor amounts of inter-bedded fine sand and coquina. The top of the Chickahominy-Piney Point Aquifer is below

the Yorktown-Easton Aquifer, approximately 810 feet below ground surface. Below the Chickahominy-Piney Point Aquifer are the Upper, Middle, and Lower Potomac aquifers.

### 3.2.5 Soils

There are 11 soil units within Fort Story (Geo-Marine, Inc. 2005). These soils consist of well-drained sands and gravels with regions of shells along the beach front, dunes in the northern portion of the installation, and poorly-drained clay and muck in the wetland areas along the southern boundary. The ridges are comprised of sands, and the forested lowland soils consist of mucky peat.

### 3.2.6 Surface Water

There are limited surface water features at Fort Story due largely to high water infiltration rate of the sandy soils. Four man-made lakes with a total surface area of roughly 10 acres are scattered throughout the installation (Geo-Marine, Inc. 2005) (**Figure 3-3**). The lakes do not have inlet or outlet streams and are likely a surface expression of the water table, measured to be within 2.5 feet of the ground surface. Engineered drainage systems direct stormwater runoff that does not infiltrate the porous soil into the bay, ocean, and wetlands through several drains and outfalls.

### 3.2.7 Vegetation

Along the coast, the vegetation is composed of 160 acres of sparsely vegetated coastal dunes populated by beachgrass, broomsedge, sea oats, panic grasses, and dune sandbur (Geo-Marine, Inc. 2005). The sparse vegetation gives way to forested freshwater wetland areas along the southern installation boundary (**Figure 3-3**). These forested wetlands consist of young (40-year-old) black gum, red maple, and bald cypress trees.

## 3.3 Munitions/Release Profile

### 3.3.1 Potential MCOC

Small caliber (blank) ammunition, demolition materials, and pyrotechnics are authorized for use at Fort Story. The source areas and potential MCOC at Fort Story are summarized in the following table:

**Table 3-2: Source Areas and Potential MCOC at Fort Story**

Range Type	Source Areas	Potential MCOC	Detected MCOC
Maneuver and training areas	None	None	None sampled
Navy EOD training area	Localized impact areas surrounding targets	Cyclotrimethylenetrinitramine (RDX), cyclotetramethylenetetranitramine (HMX), pentaerythritoltetranitrate (PETN), perchlorate, and trinitrotoluene (TNT)	None sampled

Small caliber ordnance, along with pyrotechnics, obscurants, and other types of munitions, have been used at Fort Story. MCOC associated with each category of munitions include:



- **Small Caliber Munitions:** Lead is the primary potential MCOC. Other metals, including antimony, copper, zinc, and tungsten can also contribute to impacts to environmental media (soil, surface water, and groundwater) at small arms ranges. Small caliber blanks are not considered to contain any MCOC.
- **Pyrotechnics and Obscurants:** Perchlorate compounds are a primary component of many pyrotechnics.
- **Other Munitions:** PETN is a component of detonation cords and could be a potential MCOC at ranges where demolition training is performed. Additionally, the explosive components used in some of these munitions may result in the release of TNT, RDX, and HMX.

A prioritized list of munitions containing perchlorate has been developed by USAEC and USACHPPM. These munitions account for 96 percent of the U.S. Army's annual perchlorate expenditures. These munitions were not used/used in limited amounts during training activities; therefore, perchlorate has been excluded from the list of potential MCOC evaluated for Fort Story.

### 3.3.2 Release Mechanisms/Migration Pathways

MCOC from source areas described above potentially impact source media, including soil (i.e., found in localized impact areas surrounding targets) and surface water/sediment (i.e., via direct deposition into streams and/or wetlands).

MCOC can be released to groundwater, downgradient surface water/sediment, off-site soil, or the food chain via a variety of release mechanisms. Release mechanisms for soil may include leaching from soil to groundwater, or erosion and runoff to off-range surface soil or to nearby streams. Once deposited in surface water/sediment, potential MCOC can migrate downstream, recharge the shallow groundwater, or be taken up by plants or animals.

Release mechanisms that enable transport of potential MCOC from soil or surface water/sediment source areas toward off-range receptors are present in the operational range areas at Fort Story. Both surface water and groundwater pathways were identified for soil sources in the Navy EOD training area.

At Fort Story, potential MCOC can be mobilized to groundwater via leaching and infiltration to the shallow groundwater aquifer because the operational range areas are located within the shallow groundwater aquifer recharge areas. Groundwater in the area is typically less than 2.5 feet below ground surface.

## 3.4 Land Use and Human Receptor Profile

### 3.4.1 Current Land Use

Land use surrounding Fort Story is limited by a densely forested state park to the south, the open ocean to the northeast, and the Chesapeake Bay to the northwest. A residential area along the coast is located to the south of the southwestern boundary of the installation.

### **3.4.2 Adjoining Areas of Concern**

There are no properties/areas of concern (e.g., other installations and their ranges) adjoining Fort Story that could contribute MCOC to the environment.

### **3.4.3 Current Human Receptors**

The resident population of Fort Story is approximately 600. Land use surrounding Fort Story consists of residential housing and commercial businesses. Virginia Beach City, Virginia, located immediately off-post to the south of the installation, has a population of approximately 430,000.

### **3.4.4 Resource Use Location**

Local off-range surface water bodies potentially receiving water originating from Fort Story are Broad Bay, the Chesapeake Bay, and the Atlantic Ocean. These water bodies are used as recreational areas as they are brackish or saline. Hospital Road Lake on-post is open for fishing.

The public water supply for the Virginia Beach and Norfolk areas is Lake Gaston in Brunswick County, Virginia, approximately 70 miles to the west. No other water supply wells are present within four miles of the Fort Story operational range boundary (Virginia Department of Health 2005).

## **3.5 Ecological Receptor Profile**

### **3.5.1 Sensitive Environments**

Fort Story is in the Atlantic Coastal Flatwoods section of the Outer Coastal Plain Mixed Forest ecoregion on the southern shore of the Chesapeake Bay and Atlantic Ocean confluence (Geo-Marine, Inc. 2005). The open sand beaches along the coast at the northern border of Fort Story give way to dunes and flatlands to the south which, in turn, transition to forested wetlands. First Landing State Park is an uninhabited wetland forest area that serves as a buffer between the southern Fort Story boundary and the nearby communities.

### **3.5.2 Habitat Type(s)**

Fort Story is located at the northern end of the Cape Henry Peninsula. There are three habitat regions at Fort Story (Geo-Marine, Inc. 2005). The northern boundary along the beach consists of open oceanfront dunes. Flora species common to this area are American beachgrass, broomsedge, sea oats, panic grasses, dune sandbur, and black cherry. To the south, the beaches transition to interior wooded dunes with inter-dune wetlands. This area is predominantly maritime forest habitat and is inhabited by flora of types including loblolly pine, water oak, southern red oak, live oak, and pignut hickory. Flora species of the low wooded wetland habitat of the south central region of the installation include loblolly pine, sycamore, wax myrtle, southern bayberry, and black willow.

### **3.5.3 Ecological Receptors**

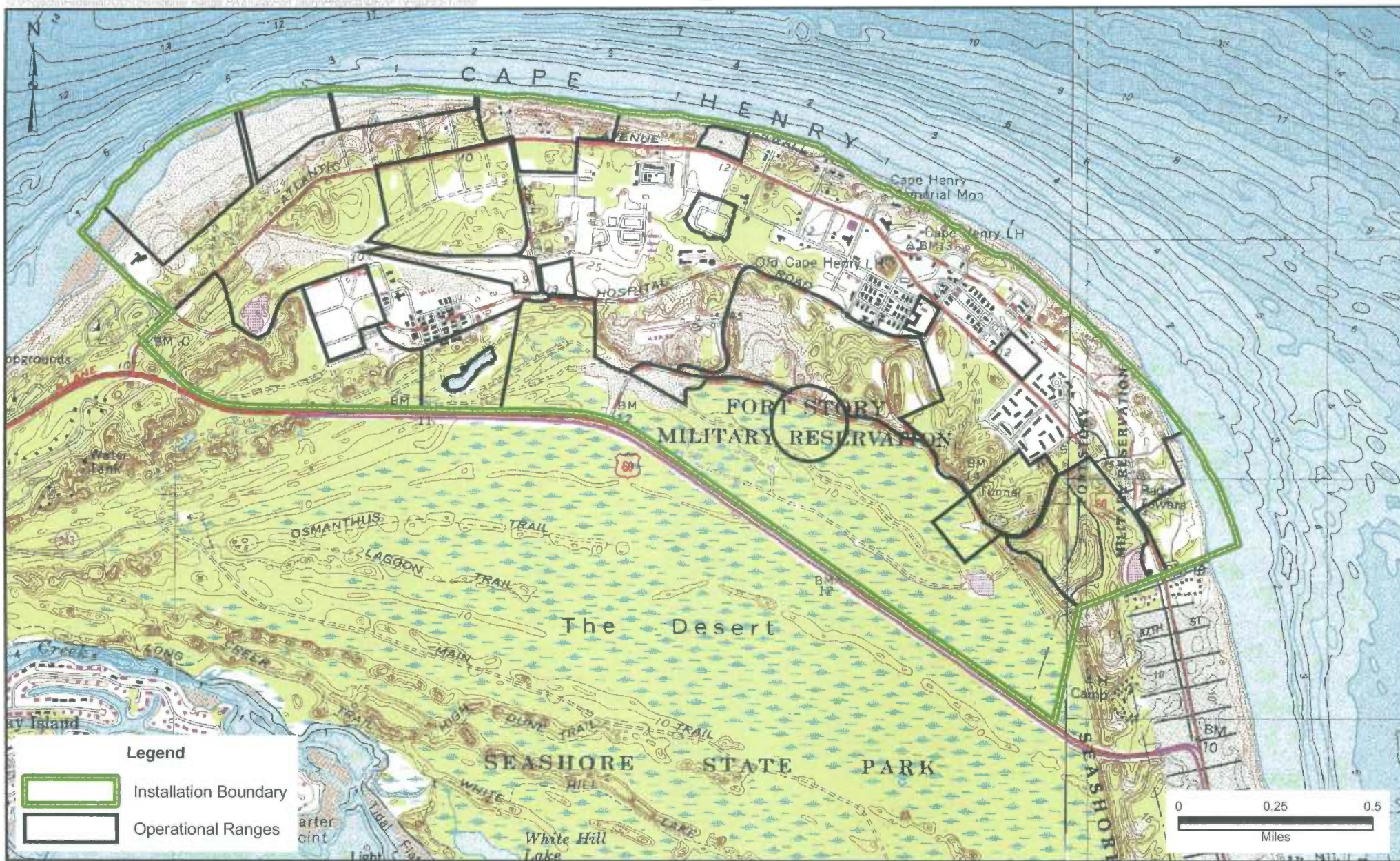
There are no federally listed species present at Fort Story (Geo-Marine, Inc. 2005). The beaches on the north boundary of Fort Story provide sufficient habitat for Loggerhead sea turtles, which are a federally listed threatened species; however, the species is not known to be present on the installation. Rafinesque's big-eared bat (*Corynorhinus rafinesquii macrotis*) is the only state-listed endangered

species known to inhabit Fort Story (Figure 3-3). Chicken turtles (*Deirochelys reticularia*), also state endangered, inhabit First Landing State Park located to the south of Fort Story. Additionally, 13 state-ranked plant species and nine state-ranked invertebrate species are known to occur within a two-mile radius of the installation (Geo-Marine, Inc. 2005).

### **3.6 Relationship of Potential MCOC Sources to Habitat and Potential Off-Range Receptors**

The EOD training area is the only source of potential MCOC. Groundwater flows from this region to the south where it discharges to the wetlands that are connected to First Landing State Park. The wetlands located downgradient of the operational range areas are likely to provide habitat for endangered species; therefore, they present a pathway between potential sources of MCOC and off-range ecological receptors.





**Operational Range Assessment Program  
Phase I Qualitative Assessment  
Fort Story, VA**

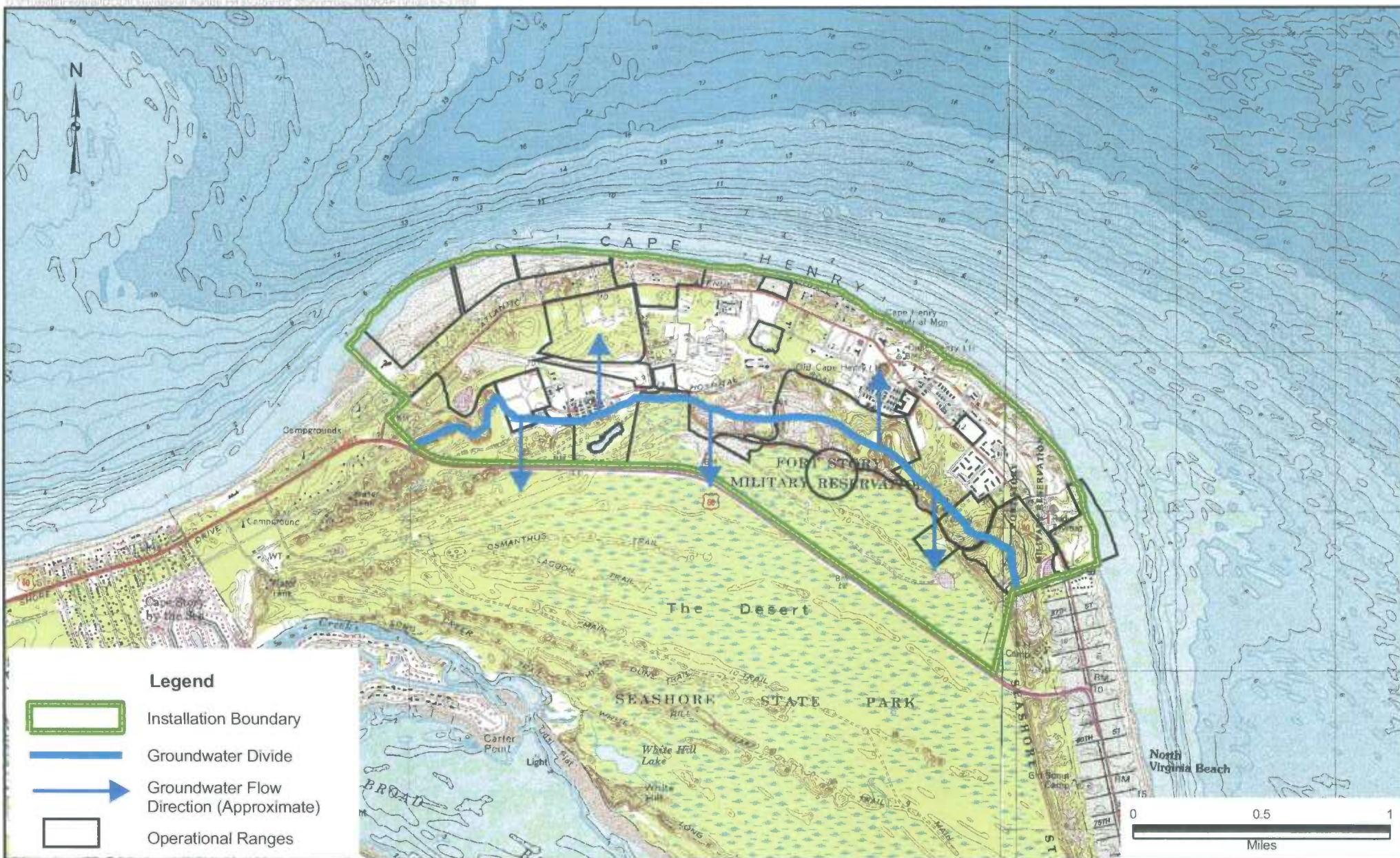
**Figure 3-1  
Topography**

Data Sources: ESRI 2005, ARID-GEO 2006

Date: .....November 2006  
Prepared By: ...EA Engineering Science and Technology  
Prepared For: .....U.S. Army  
Contract Number: .....W912DR-05-D-004











**Operational Range Assessment Program  
Phase I Qualitative Assessment  
Fort Story, VA**

**Figure 3-3  
Surface Water, Wetlands, and Threatened and Endangered Species**

Data Sources: ESRI 2005, ARID-GEO 2006, ITAM 2006

Date: .....November 2006  
Prepared By: ...EA Engineering Science and Technology  
Prepared For: .....U.S. Army  
Contract Number: .....W912DR-05-D-004

## 4.0 Grouping and Categorization Methods

### 4.1 Grouping Rationale

The March 2006 ARID-GEO data identified operational ranges within the installation boundaries. The identified operational ranges may contain many ranges, firing points, or other activities. For the purpose of the Phase I Assessment, the operational range areas could be divided into any of the following possible groups based on three CSM components: source of MCOC, migration pathway, and receptors:

- **LS:** Limited or no munitions have been used on the range.
- **MPU:** Munitions have been used on the range, but migration pathways are unlikely or incomplete.
- **MSW:** Munitions have been used on the range. A surface water migration pathway was identified, but no receptors have been identified.
- **MGW:** Munitions have been used on the range. A groundwater migration pathway was identified, but no receptors have been identified.
- **MSWGW:** Munitions have been used on the range. Groundwater and surface water migration pathways have been identified, but no receptors have been identified.
- **MSW (H/E):** Munitions have been used on the range. The surface water source-receptor interaction is potentially complete (for human or ecological receptors).
- **MGW (H/E):** Munitions have been used on the range. The groundwater source-receptor interaction is potentially complete (for human or ecological receptors).
- **MSWGW (H/E):** Munitions have been used on the range. The surface water and groundwater source-receptor interactions are potentially complete (for human or ecological receptors).

A “No Off-Range Release” determination can be designated in the event that an operational range area has a source of MCOC, a pathway/release mechanism, and an identified off-range receptor. In such cases, the sampling data must indicate, based on professional judgment, that no source-receptor interaction exists (i.e., either source or off-range MCOC are not at a level which may pose an unacceptable risk to human health or the environment). In such a case, the phrase “No Release” is added to the appropriate group established above for the description of the operational range area (i.e., MSWGW (H/E) – No Release), and associated text explains the rationale for the source-receptor interaction.

### 4.2 Categorization Rationale

Ranges in groups MSW (H/E), MGW (H/E), and MSWGW (H/E) are designated as either Referred or Inconclusive, depending on the availability of actual sampling data. If one or more MCOC is present in off-range media (e.g., groundwater, sediment, surface water, or soil) at levels that present an unacceptable risk to human health and/or the environment as confirmed through compelling sampling data, then the ranges in any of these three groups (MSW [H/E], MGW [H/E], and MSWGW [H/E])

will be placed into the Referred category. If sampling data are unavailable or insufficient to assess definitive impacts, then the ranges in these groups will be placed into the Inconclusive category. Ranges in the LS, MPU, MSW, MGW, and MSWGW groups are automatically designated as Unlikely because at least one CSM component (source of MCOC, pathway, or receptor) is absent. The categorizations are summarized as follows:

- **Referred – Refer to Appropriate Cleanup Program:** Ranges with compelling evidence (e.g., sampling data) to indicate the presence of an off-range release that potentially poses an unacceptable risk to human health or the environment;
- **Inconclusive – Phase II Quantitative Assessment Required:** Ranges where existing information either is insufficient to make a source-receptor interaction determination or indicates the potential for such interaction to be occurring; or
- **Unlikely – Five-Year Review<sup>4</sup>:** Ranges where, based upon a review of readily available information, there is sufficient evidence to show that there are no known releases or source-receptor interactions that could present an unacceptable risk to human health or the environment based on a review of the information available.

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<sup>4</sup> All operational ranges must be periodically re-evaluated to determine if there is a release or substantial threat of release of MCOC from an operational range to an off-range area. Range groups categorized as Unlikely are to be re-evaluated at least every five years. Re-evaluation may occur sooner if significant changes (e.g., changes in range operations, site conditions, and regulatory changes) occur that affect determinations made during the Phase I Assessment.



## **5.0 Conceptual Site Model Narrative**

The operational ranges at Fort Story have been placed into two groups: LS and MSWGW (E). The rationale for placing the ranges in these groups is discussed in the sections below and is based on the source of potential MCOC, exposure pathways, and potential receptors. This information will determine if there is a potential source-receptor interaction for each relevant pathway identified, which will be used to determine the appropriate categorization for each group. **Figure 5-1** depicts the range groupings which are described below. The potential source-receptor interactions are based on the CSM components described below and depicted on **Figure 5-2** for Group LS and **Figure 5-3** for Group MSWGW (E). **Table 5-1** provides site-specific information concerning the CSM components for each group identified within Fort Story, including potential sources, source media, release mechanisms, exposure media, exposure routes, and receptors.

### **5.1 Group LS**

#### **5.1.1 Primary Source and MCOC**

The maneuver and training areas at Fort Story are located along the beachfront, adjacent to the cantonment area, and along the southern border. These areas are used for land navigation training, vehicle maneuver training, bivouac areas, and other non-live-fire activities. These areas have non-concentrated use of pyrotechnics and simulators. This activity does not create a significant source of MCOC. Therefore, no source media, pathway, or receptor evaluations were conducted for these ranges. There are no potentially complete human or ecological-source-receptor pathways within this group.

#### **5.1.2 Source Media**

No source media evaluation was conducted for these ranges.

#### **5.1.3 Pathway Analysis**

No pathway analysis was conducted for these ranges.

#### **5.1.4 Potential Source-Human Interaction Pathway Analysis**

No potential source-human interaction pathway analysis was conducted for these ranges.

#### **5.1.5 Potential Source-Ecological Interaction Pathway Analysis**

No potential source-ecological interaction pathway analysis was conducted for these ranges.

### **5.2 Group MSWGW (E)**

#### **5.2.1 Primary Source and MCOC**

The live-fire training area at Fort Story is limited to the EOD training area. This area consists of a detonation pit, an open detonation zone, and a non-live-fire training course that has been used continuously for more than 30 years. The detonation pit, open detonation area, and the training



course are located in an area of native sandy soils. As such, these range areas have a potential source of MCOC (i.e., HMX, RDX, TNT, perchlorate, and PETN).

### **5.2.2 Source Media**

Activities in the EOD training area concentrate potential MCOC in the detonation pit and open detonation zone. The source media for the EOD range is soil. The soil in the vicinity of the EOD training area is primarily moderately- to well-drained disturbed sand. Potential MCOC can be deposited on soil.

### **5.2.3 Pathway Analysis**

Release mechanisms within the Navy EOD training area include leaching/infiltration into the shallow Columbia aquifer because the EOD training area is located within the recharge areas for the aquifer. The potential MCOC associated with the munitions expended in this group are available for mobilization through these mechanisms.

### **5.2.4 Potential Source-Human Interaction Pathway Analysis**

Since the Columbia Aquifer is not used as a potable water supply, there are no potential human interactions.

### **5.2.5 Potential Source Ecological Interaction Pathway Analysis**

The shallow Columbia Aquifer discharges to wetlands located along the southern boundary of the EOD training area. These wetlands are directly connected to the wetlands in First Landing State Park. Downgradient surface water is potentially used as habitat and a food source for threatened and endangered species (i.e., chicken turtle); therefore, there is also opportunity for ecological interaction with impacted surface water. The source-receptor interaction pathway is potentially complete for ecological receptors.

## **5.3 Data Uncertainty**

Munitions usage data for the EOD training area were requested, but not provided. Therefore, it was not possible to estimate the potential volume of MCOC present in this area.

**Table 5-1: Summary of the Conceptual Site Model Components**

<b>Group Identification</b>	<b>Primary Source</b>	<b>Primary MCOC</b>	<b>Source Media</b>	<b>Release Mechanism</b>	<b>Exposure Media</b>	<b>Exposure Routes</b>	<b>Receptors</b>
<b>LS</b>	None	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
<b>MSWGW (E)</b>	EOD	RDX, HMX, and PETN, perchlorate	Soil, groundwater	Leaching and infiltration, groundwater discharge to surface water	Surface water/sediment and food chain	Ingestion and dermal absorption	Threatened and endangered animals



### Legend

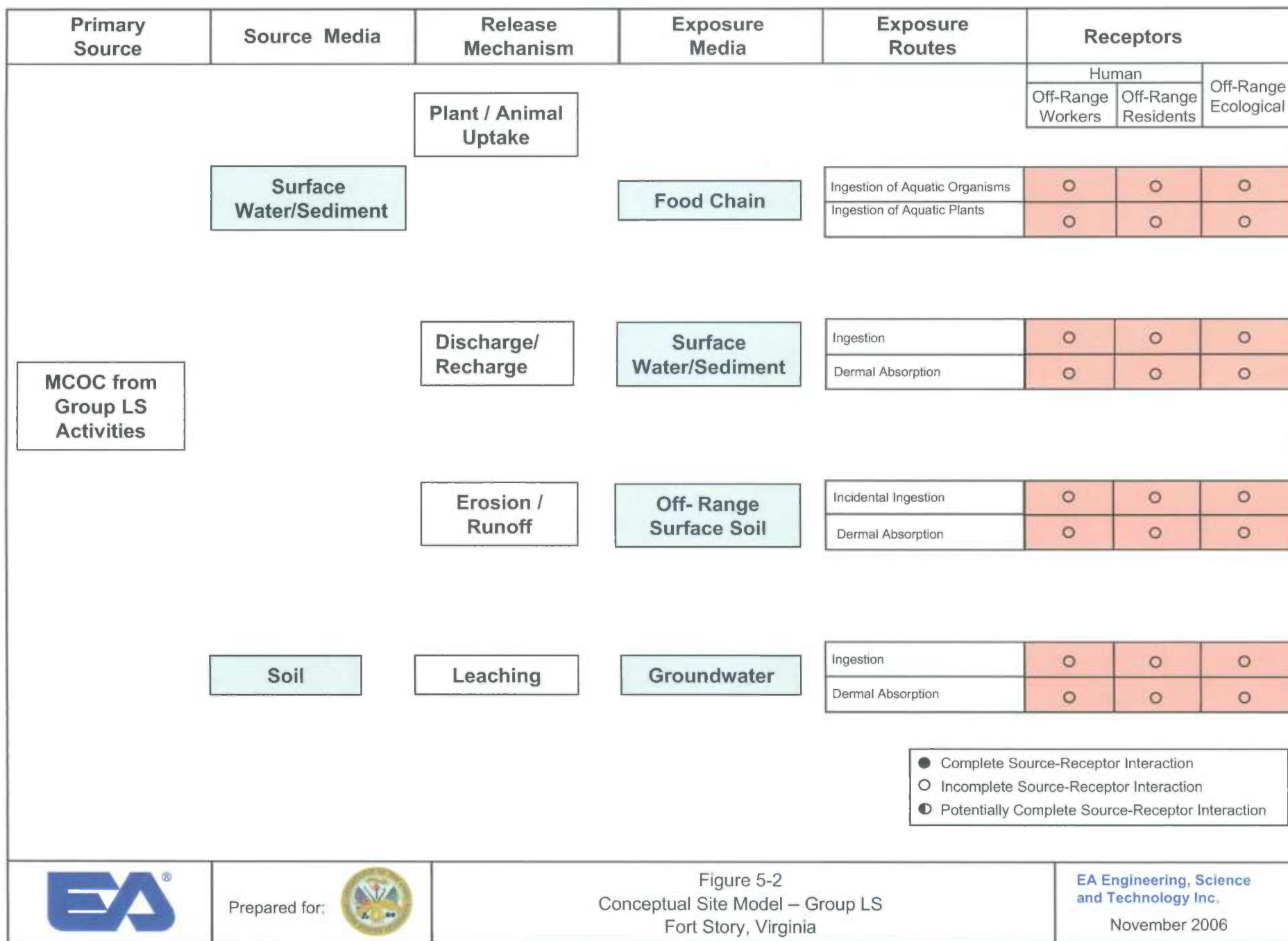
-  Installation Boundary
-  Non-Operational Area
- Groups
-  Group LS - Limited Source
-  Group MSWG(E)



## Operational Range Assessment Program Phase I Qualitative Assessment Fort Story, VA Figure 5-1 Individual Range Groupings

Data Sources: ESRI, 2005, ARID-GEO 2006

Date: ..... November 2006  
Prepared By: ..... EA Engineering Science and Technology  
Prepared For: ..... U.S. Army  
Contract Number: ..... W912DR-05-D-004



Prepared for:



Figure 5-2  
Conceptual Site Model – Group LS  
Fort Story, Virginia

EA Engineering, Science  
and Technology Inc.

November 2006



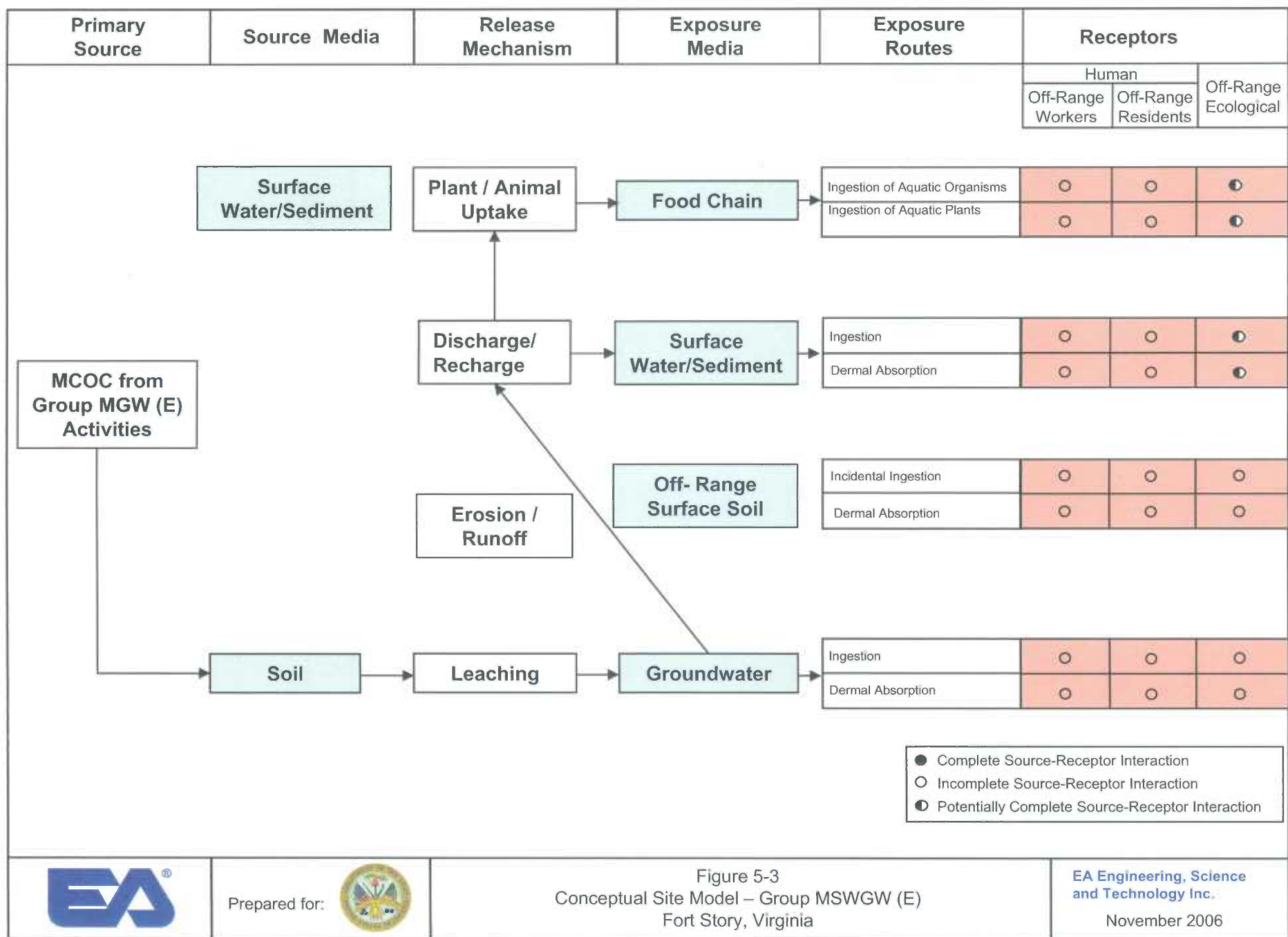


Figure 5-3  
Conceptual Site Model – Group MSWG (E)  
Fort Story, Virginia

## 6.0 Conclusions and Recommendations

The Phase I Assessment categorized the operational ranges at Fort Story as described below. **Figure 6-1** depicts the source-receptor interactions identified during the Phase I Assessment at Fort Story. The conclusions and recommendations for these operational ranges are presented in **Table 6-1**. These conclusions are based on readily available information collected to date. Re-evaluation of these conclusions and recommendations should be conducted if changes to range operations or site conditions are identified.

### Referred

Based on data reviewed during the Phase I Assessment, no operational ranges at Fort Story are categorized as Referred.

### Inconclusive

Operational ranges where a source of potential MCOC has been identified and an exposure pathway and receptors have been categorized as Inconclusive, which consists of Group MSWGW (E). One range, specifically the Navy EOD training area, was identified as having the potential for MCOC to migrate off-range and affect human or ecological receptors (based on current and historical military munitions usage at Fort Story and a review of potential migration pathways and potential human or ecological receptors). The pathway identified at this range is the native sandy soil on which ordnance is detonated.

#### **Group MSWGW (E)**

The EOD training area identified in Group MSWGW (E) covers 19.4 acres of Fort Story and has current and/or historical sources of potential MCOC that were identified during the Phase I Assessment. This range supports demolition training activities. Potential MCOC release mechanisms include leaching/infiltration.

Leaching/infiltration and subsequent discharge to surface water (e.g., nearby wetlands) may allow potential MCOC to migrate to off-site surface water. Potential contact with MCOC for ecological receptors may occur through surface water ingestion/dermal contact or via the food chain.

### Unlikely

Ranges determined to have at least one CSM component (source of potential MCOC, pathway, or receptor) absent have been categorized as Unlikely. A total of 20 ranges in the LS Group were identified as being unlikely to have potential for MCOC present to migrate off-range and affect human or ecological receptors (based on a review of current and historical military munitions usage at Fort Story and a review of potential migration pathways and potential human or ecological receptors).

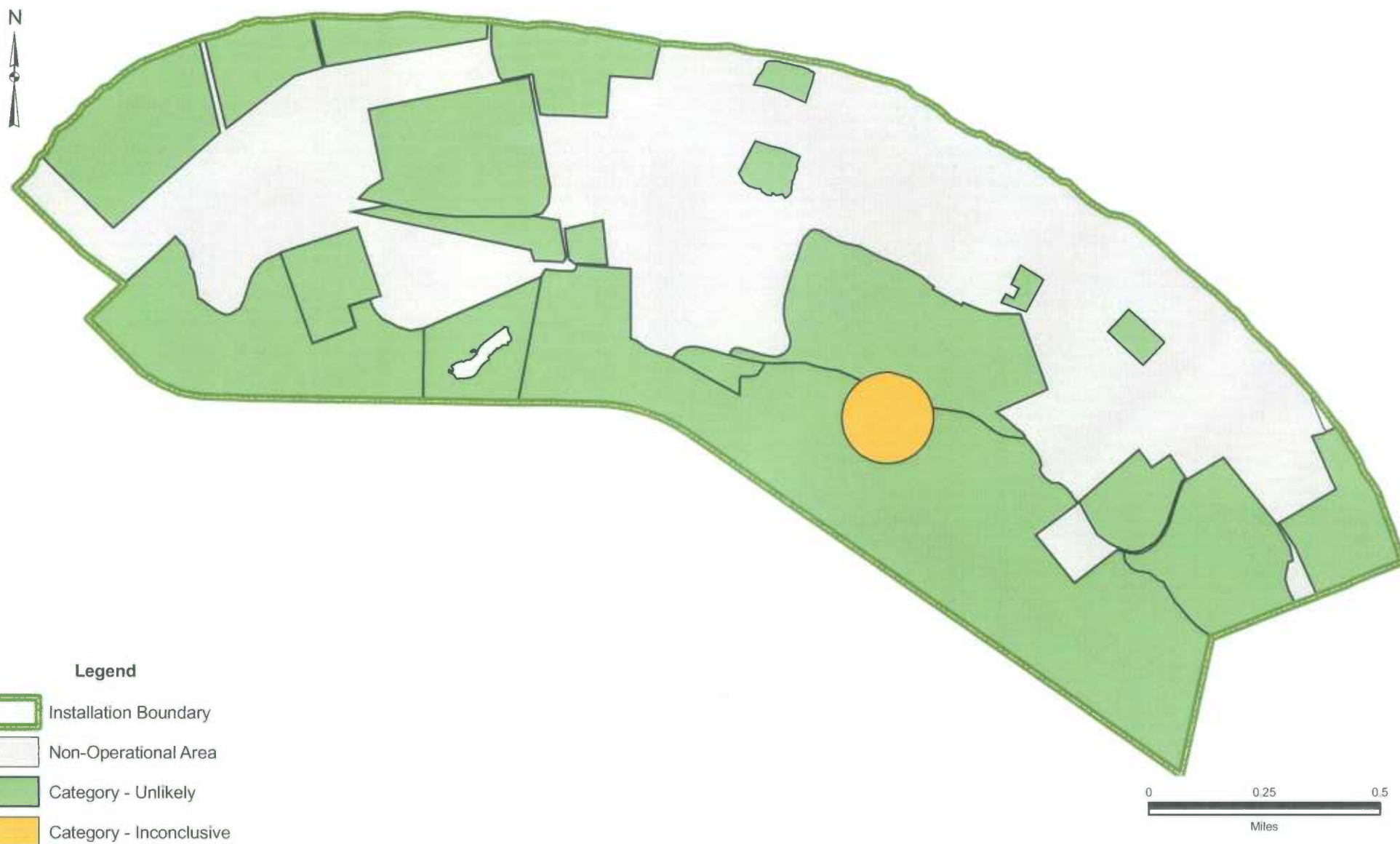
#### **Group LS**

The 20 ranges identified in Group LS cover 843 acres of Fort Story. These ranges were found to have release mechanisms, exposure media, exposure routes, and ecological receptors. However, this group consists of 20 non-live-fire maneuver and training areas that contain limited potential sources of MCOC. Therefore, there is no potential for an MCOC-receptor interaction in the 20 ranges included in this group.

**Table 6-1: Summary of Conclusions and Recommendations for Fort Story**

Category	Group Identification	Total Number of Ranges and Acreage	Source(s)	Pathway(s)*	Human Receptors*	Ecological Receptors*	Recommendations (Future Steps)
Inconclusive	Munitions used; groundwater pathway present	1 operational range; 19.4 acres	EOD detonation and training areas	Groundwater, Surface water	None	Threatened and endangered species (chicken turtle), wetlands	Phase II Quantitative Assessment is required.
Unlikely	Limited source	20 operational ranges; 843 acres	No source – limited or no military munitions use	Not evaluated	Not evaluated	Not evaluated	Re-evaluate during the five-year review.
* Indicates the specific pathways of concern.							





**Operational Range Assessment Program  
Phase I Qualitative Assessment  
Fort Story, VA  
Figure 6-1  
Summary of Conclusions for Fort Story**

Data Sources: ESRI, 2005; ARID-GEO 2006

Date: .....November 2006  
Prepared By: ..EA Engineering Science and Technology  
Prepared For: ..... U.S. Army  
Contract Number: ..... W912DR-05-D-004

## **Appendix A: Glossary of Terms**

## GLOSSARY OF TERMS

The terms outlined below are those that will be used commonly during the Phase I Assessment process. The relevant reference for each is presented at the end of the definition. If no reference is presented, then the term is not an official Department of Defense (DoD) definition and should be applied only to the Phase I Assessment process.

Dudded Impact Area – An area having designated boundaries within which all dud-producing ordnance will detonate or impact. Vehicle bodies are sometimes placed in the area to act as targets for direct and indirect artillery fire. The primary function of the impact area is to contain weapons effects as much as possible using earthen berms or natural terrain features. Impact areas containing unexploded ordnance may not be used for maneuver. Each area, typically managed and scheduled by either numeric, lettered, or alpha-numeric code through the installation training or range control manager (e.g., Directorate of Plans, Training, Mobilization and Security or equivalent), should be accounted for with a separate facility number and real property record.<sup>5</sup>

Group – A group is a collection of one or more ranges within an operational range area (range complex area) that shares similar characteristics. Similar characteristics can include types of activities, munitions usage, geographic proximity, surface water or groundwater divides, or even common receptors.<sup>6</sup>

Inconclusive – Phase II Quantitative Assessment Required – Ranges where existing information either is insufficient to make a source-receptor interaction determination or indicates the potential for such interaction to be occurring.<sup>6</sup>

Large Caliber – Munitions include projectiles greater than 60 millimeters (including 75-, 76-, 81-, 90-, 105-, and 155-millimeter, and 14- and 16-inch projectiles).<sup>6</sup>

Medium Caliber – Munitions include projectiles sized from 20- to 60-millimeters (including 20-, 25-, 30-, 37-, 40-, and 60-millimeter projectiles).<sup>6</sup>

Military Munitions – All ammunition products and components produced or used by the armed forces for national defense and security, including ammunition products or components under the control of the DoD, the U.S. Coast Guard, the U.S. Department of Energy, and the Army National Guard. The term military munitions includes: confined gaseous, liquid, and solid propellants; explosives; pyrotechnics; chemical and riot control agents; smoke and incendiaries, including bulk explosives and chemical warfare agents; chemical munitions; rockets; guided and ballistic missiles; bombs; warheads; mortar rounds; artillery ammunition; small arms ammunition; grenades; mines; torpedoes; depth charges; cluster munitions and dispensers; demolition charges; and devices and components thereof. Military munitions do not include wholly inert items; improvised explosive devices; and nuclear weapons, nuclear devices, and nuclear components, other than non-nuclear components of nuclear devices that are managed under the nuclear weapons program of the Department of Energy after all required sanitization operations under the Atomic Energy Act of 1954 (42 United States Code [U.S.C.] 2001 et seq.) have been completed. (10 U.S.C. 101[e][4][A] through [C])

<sup>5</sup> Definition derived from the Department of the Army Pamphlet 415-28 Guide to Army Real Property Category Codes (11 February 2000).

<sup>6</sup> This definition was based on guidance from the U.S. Army Operational Range Assessment Program Qualitative Assessments Protocol (November 2005), as well as further input/guidance from the USAEC and USACHPPM.



Munitions Constituents (MC) – Any materials that originate from unexploded ordnance, discarded military munitions, or other military munitions, including explosive and non-explosive materials, and emission, degradation, or breakdown elements of such ordnance or munitions. (10 U.S.C. 2710[e][3])

Munitions Constituents of Concern (MCOC) – Those MC that have the potential to migrate from a source area to a receptor (human or ecological) in sufficient quantity to cause an unacceptable risk to human health or the environment. (DoD Instruction [DODI] 4715.14, 30 November 2005) MCOC for high explosives include: trinitrotoluene; HMX; PETN; RDX; dinitrotoluene; 2,6-dinitrotoluene; and white phosphorus. MCOC for small arms include lead, antimony, copper, zinc, and tungsten. MCOC for training areas include perchlorate.<sup>6</sup>

Non-Dudded Impact Area – An area having designated boundaries within which ordnance that does not produce duds will impact. This area is composed mostly of the safety fans for small arms ranges. The primary function of the impact area is to contain weapons effects as much as possible using earthen berms or natural terrain features. Each area, typically managed and scheduled by either numeric, lettered, or alpha-numeric code through the installation training or range control manager (e.g., Directorate of Plans, Training, and Mobilization or equivalent), should be accounted for with a separate facility number and real property record. These impact areas may be used for maneuver, at the cost of curtailing the use of weapons ranges.<sup>5</sup>

Off-Range Area – For the purpose of the Phase I Assessment, off-range areas include those areas outside of the boundaries of the operational range area as established by the Army Range Inventory Geodatabase (ARID-GEO). Off-range areas may include both on- (e.g., cantonment areas) and off-installation locations.

Operational Range – A range that is under the jurisdiction, custody, or control of the Secretary of Defense and that is used for range activities or, although not currently being used for range activities, that is still considered by the Secretary to be a range and has not been put to a new use that is incompatible with range activities. (10 U.S.C. 101[e][3])

Other Munitions – Munitions from aerial fire (rockets and large bombs), hand grenades, light anti-tank weapons, and anti-armor missiles.<sup>6</sup>

Pathway – The environmental medium through which an MCOC is transported from the source to the receptor. (DODI 4715.14, 30 November 2005)

Range – The term range, when used in the geographical sense, means a designated land or water area that is set aside, managed and used for range activities of the DoD. The term includes: (A) firing lines and positions, maneuver areas, firing lanes, test pads, detonation pads, impact areas, electronic scoring sites, buffer zones with restricted access, and exclusionary areas and (B) airspace areas designated for military use in accordance with regulations and procedures proscribed by the Administrator of the Federal Aviation Administration. (10 U.S.C. 101 [e][1][A] and [B])

Range Complex – For the purpose of the Phase I Assessment, range complexes are contiguous operational ranges that may be grouped together and assessed as a single range (also referred to as an operational range area).

Receptor – A human, animal, or plant species that is exposed, or that may be exposed, to MC. (DODI 4715.14, 30 November 2005)

Referred – Ranges with compelling evidence (e.g., sampling data) to indicate the presence of an off-range release that potentially poses an unacceptable risk to human health or the environment.<sup>6</sup>

Sensitive Environments – Terrestrial or aquatic resources, fragile natural settings, or other areas with unique or highly valued environmental features.<sup>6</sup>

Small Arms – Small arms include all shotgun, 0.22-, 0.223-, 0.30-, 0.32-, 0.38-, 0.45-, and 0.50-caliber, and 5.56-, 7.62-, 9-, and 10-millimeter weapons.<sup>6</sup>

Small Caliber – Munitions used in small arms and fired from weapons with muzzle diameter of up to 0.50-caliber or one-half inch.<sup>6</sup>

Source – An area where MC may have been deposited, disposed, or placed. (DODI 4715.14, 30 November 2005)

Training Area – For the purpose of the Phase I Assessment, training areas refer to the ranges that have non-live-fire troop activities. These areas can have a variety of activities that include bivouac, troop movement, and tactics.

Unknown Munitions – Items that have not been identified or positively identified.<sup>6</sup>

Unlikely – Five-Year Review – Ranges where, based upon a review of readily available information, there is sufficient evidence to show that there are no known releases or source-receptor interactions that could present an unacceptable risk to human health or the environment based on a review of the information available.<sup>6</sup>

## **Appendix B: References**

**B1 – General/Project Drivers and Guidance Documents**

**B2 – References**

**B3 – Data Repositories and Databases**

**B4 – On-Installation Sources/Repositories**

**B5 – Personnel Interviews**

**B6 – Off-Installation Sources/Repositories**



## **B1 – General/Project Drivers and Guidance Documents**



Department of Defense Directive 4715.11 Environmental and Explosive Safety Management on Operational Ranges within the United States. 10 May 2004.

Department of Defense Instruction 4715.14 Operational Range Assessments. 30 November 2005.

Final Work Plan/Management Plan for the Operational Range Assessment Program Qualitative Operational Range Assessments. December 2005.

U.S. Army Operational Range Assessment Program Qualitative Assessments Protocol. Prepared by U.S. Army Center for Health Promotion and Preventive Medicine Army Operational Range Assessment Team. November 2005.

U.S. Environmental Protection Agency Guidance for Performing Preliminary Assessments under Comprehensive Environmental Response, Compensation, and Liability Act EPA/540/G-91/013: U.S. Environmental Protection Agency Soil Exposure Pathway Targets. September 1991.

U.S. Environmental Protection Agency Interim Final Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments. June 1997.



## **B2 – References**



Fort Story. [http://www.eustis.army.mil/Fort\\_story/](http://www.eustis.army.mil/Fort_story/). 2006.

Geo-Marine, Inc. Integrated Natural Resources Management Plan (Plan Years 2004-2008), U.S. Army Transportation Center, Fort Story, Virginia. 2005.

Malcolm Pirnie, Inc. Remedial Investigation Report, 80<sup>th</sup> Division Reserve Site (Draft), Installation Restoration Program, Fort Story, Virginia. 2005.

Malcolm Pirnie Inc. Remedial Investigation, Volume I and II, Firefighter Training Area, LARC 60 Maintenance Area, Auto Craft Building Area, Fort Story, Virginia. 2002.

Montgomery Consulting Engineers, Inc. Fort Story Remedial Investigation/Pre-Feasibility Study. 1991.

Virginia Department of Health. 2005. Wellhead protection GIS data.



## **B3 – Data Repositories and Databases**



**Army Knowledge Online**

No relevant information/documentation was obtained.

**Army Range Inventory Geodatabase**

GIS data for current operational ranges.

Digital Elevation Model.

Digital Orthophotography.

**Encroachment Conditions Module**

No relevant information/documentation was obtained.

**Environmental Data Resources, Inc.**

No relevant information/documentation was obtained.

**Environmental Restoration Information System**

No relevant information/documentation was obtained.

**Geographic Information System – Repository**

No relevant information/documentation was obtained.

**Guard Knowledge Online**

Installation history and current use information.

**Integrated Training Area Management**

GIS data for the location of threatened and endangered species and wetlands.

**Range Facility Management Support System**

No relevant information/documentation was obtained.

**Technical Information Center**

Malcolm Pirnie Inc. Remedial Investigation, Volume I and II, Firefighter Training Area, LARC 60 Maintenance Area, Auto Craft Building Area, Fort Story, Virginia. 2002.

Malcolm Pirnie, Inc. Remedial Investigation Report, 80<sup>th</sup> Division Reserve Site (Draft), Installation Restoration Program, Fort Story, Virginia. 2005.

Montgomery Consulting Engineers, Inc. Fort Story Remedial Investigation/Pre-Feasibility Study. 1991.

Montgomery Consulting Engineers, Inc. Final Site Investigation Report for the Fort Story Preliminary Assessment/Site Investigation and Fort Story Nike Preliminary Assessment/Site Investigation, Fort Story, Virginia. 1992.

**Training Center Sustainment Initiative**

No relevant information/documentation was obtained.



## **B4 – On-Installation Sources/Repositories**



**Environmental Office**

Geo-Marine, Inc. Integrated Natural Resources Management Plan (Plan Years 2004-2008), U.S. Army Transportation Center, Fort Story, Virginia. 2005.

**Range Control Office**

No relevant information/documentation was obtained.

## **B5 – Personnel Interviews**





Environmental and Natural Resources Division, Department of Public Works, Environmental and Natural Resources Specialist and Wildlife Biologist

Date of interview: 18 April 2006 by Matthew Hoskins (EA Engineering, Science, and Technology, Inc.)

No documents obtained.

Environmental and Natural Resources Division, Department of Public Works, Restoration Branch Chief

Date of interview: 20 April 2006 by Matthew Hoskins and Jennifer Martin (EA Engineering, Science, and Technology, Inc.)

Provided: Malcolm Pirnie Inc. Remedial Investigation, Volume I and II, Firefighter Training Area, LARC 60 Maintenance Area, Auto Craft Building Area, Fort Story, Virginia. 2002;  
Geo-Marine, Inc. Integrated Natural Resources Management Plan (Plan Years 2004-2008), U.S. Army Transportation Center, Fort Story, Virginia. 2005.

Fort Story Range Operations, Range Officer and Fort Story Range Operations, Antiterrorism Officer

Date of interview: 20 April 2006 by Matthew Hoskins, Jennifer Martin, Heidi Kuziak, and John Monk (EA Engineering, Science, and Technology, Inc.)

Provided Fort Story Range Tour

Requested range munitions usage for the EOD, John Monk to follow up with range control officer.

Integrated Training Area Management, GIS Analyst

Date of interview: 18 April 2006 by Matthew Hoskins (EA Engineering, Science, and Technology, Inc.)

Provided data for locations of wetlands and threatened and endangered species.

## **B6 – Off-Installation Sources/Repositories**





### **Federal Offices**

Bureau of Land Management. Partners In Flight, Physiographic Area Plans.  
<http://www.blm.gov/wildlife/pifplans.htm>.

National Climatic Data Center, Southwest Regional Climate Center.  
<http://www.dnr.sc.gov/climate/sercc/climateinfo/historical/historical.html>.

National Oceanographic and Atmospheric Administration.  
[http://www.ocrm.nos.noaa.gov/czm/czm\\_act.html](http://www.ocrm.nos.noaa.gov/czm/czm_act.html).

Natural Resources Conservation Service. <http://websoilsurvey.nrcs.usda.gov>.

U.S. Census Bureau. <http://factfinder.census.gov>,

U.S. Department of Agriculture, Forest Service, NE Area, Threatened and Endangered Species.  
[http://www.na.fs.fed.us/spfo/pubs/wildlife/endangered/end\\_species.htm](http://www.na.fs.fed.us/spfo/pubs/wildlife/endangered/end_species.htm)

U.S. Environmental Protection Agency, National Estuary Program.  
<http://www.epa.gov/owow/estuaries/programs/se.htm>

U. S. Fish and Wildlife Wetland Online Mapper. <http://www.fws.gov/>.

U.S. Geological Survey. <http://waterdata.usgs.gov/va/nwis/current/?type=gw>.

### **State Offices**

Virginia Department of Health. Wellhead protection GIS data.

Virginia Fish and Wildlife Information Service. <http://vafwis.org/WIS/asp/default.asp>.

Virginia Natural Heritage Program. <http://www.state.va.us/dcr/dnh/nhrinfo.htm>.